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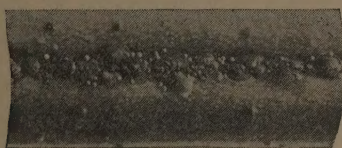
CONNECTICUT AGRICULTURAL EXPERIMENT STATION

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ENTOMOLOGICAL SERIES, No. 10.

Fighting the San José Scale-Insect in 1903.



CONTENTS.

	Page.
Officers and Staff of Station	2
Fighting the San José Scale-Insect	3
Spraying Dormant Trees	3
Experiments at Yalesville	4
Westville Experiments	9
Spraying at Southington	14
New Haven Experiments	18
Other Experiences	20
Summer Spraying with Kerosene Emulsion	22
Making the Lime, Sulphur and Salt Mixture	22
Weather Notes	25
Summary	26

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FIGHTING THE SAN JOSÉ SCALE-INSECT IN 1903.

By W. E. BRITTON AND B. H. WALDEN.

During the season of 1903, spraying experiments directed against this most destructive insect were conducted at Yalesville, Southington, Westville and New Haven.

One of the most extensive spraying operations ever conducted in the State was carried out at the orchard of Barnes Brothers at Yalesville. A short account of the work done in this orchard in 1902 was given in the Second Report of the State Entomologist, page 120. During March and April of the present year, about 11,000 trees were sprayed by the owners, and a brief account has been published in the Report of the Connecticut Pomological Society for 1902, page 217.

Barnes Brothers cordially coöperated with the Station in experimenting with various mixtures, and especially in developing practical methods of preparing and applying them, in order to make the work of greater value to the orchardists of the State.

At Southington, the writers sprayed over 200 peach and 50 apple trees with various substances during the latter part of March. Some of the mixtures were not effective in killing the scales and 100 of the peach trees were again sprayed August 10th, to prevent the further increase of the insects.

Various spraying mixtures were tested on about 150 pear trees in Westville on April 1st.

Late in the winter some fruit trees upon the Station grounds were found to be moderately infested, and several preparations were here applied to 35 trees of various kinds during March and April.

The results of the experiments have been tabulated and these, together with a somewhat detailed account of the conditions under which they were made, as well as a few practical directions for doing the work, appear in the following pages.

SPRAYING DORMANT TREES.

Most of the experimental work consisted in spraying the dormant trees in late winter or early spring with various insecticides. The results of the spraying are measured by the pro-

portion of scale-insects which are killed by it. But since from fifteen to thirty per cent. of the scales usually die each winter, and sometimes even fifty per cent., it is necessary first to determine the percentage which are alive when the spraying is done.

In each case, therefore, before spraying, sample twigs were cut from marked trees and the percentage of living scales determined. Twigs from the same trees were taken some six or eight weeks after treatment to determine the effect of the insecticides.

This second count was made during June in all cases. At this time the hibernating males had reached maturity and had emerged, nothing but the shells remaining. These can readily be distinguished from the females by their different shape, and were not counted in determining the percentages. Though this method of indicating results has its faults and should not be the only kind of record kept, it furnishes, nevertheless, a means of expressing the results in a mathematical statement, and when combined with the method of frequently examining the trees, is believed to afford a more accurate account than can come from a personal estimate not based upon an actual enumeration.

In all of the work herein described, the trees were sprayed as well as could be, but on account of winds it was almost impossible some days to thoroughly coat the trees. After the first application dried, the trees were again visited and all branches not coated the first time were "touched up."

Experiments at Yalesville.

The work here was done on a very extensive scale by the owners. Throughout the orchards, infested trees could be found here and there, but very few were badly infested and no portion of the orchard was thoroughly or uniformly infested. On most trees the insect could not be found. The owners, wishing to check the pest before the trees were seriously injured by it, sprayed nearly their entire orchards.

Under these conditions, it was impracticable to test many different insecticides as the infested trees were widely scattered, and it was difficult to find many infested trees from which to cut twigs, especially after the trees had been pruned. It was

an excellent opportunity, however, to test practically the methods of making and applying insecticides on a large scale.

A description of Barnes Brothers' steam cooking plant for making the lime, sulphur and salt mixture (California wash) was published in the Second Report of the State Entomologist, 1902, page 120, and the boiler was figured on Plate III of the same.

This outfit was used in the season of 1903, but the boiler was supplemented by the boiler of a Kinney "Safe" engine in order to increase its capacity. Three hand barrel pumps were used for spraying, each pump being fitted with a 25-foot half-inch hose, 8-foot gas-pipe extension and double Vermorel nozzle. The barrels were mounted upon stone-drags, fitted with heavy wooden blocks hollowed out in such a manner as to prevent the barrel from slipping out of place. When spraying the trees near the cooking plant, the barrels were filled directly from it, but the mixture was carted to distant portions of the orchard in storage barrels, from which it was drawn into the pump barrels. The storage barrels and mounted pump are shown on Plate II, b.

About half of the trees, which had been planted six and seven years, were severely cut back before spraying. As the fruit-buds had nearly all been winter-killed, the time was a very good one for heading back the trees (see Plate I, a). It was also possible to spray the trees more thoroughly and cheaply after cutting them back.

Nevertheless, the treatment of this orchard was expensive, as is shown by the figures kindly submitted by Mr. Barnes.

Labor	\$472.80
Four horses, 75 cents each per day, 30 days	90.00
Materials—16,500 lbs. lime, 13,680 lbs. sulphur, 7,840 lbs. salt	500.00
Fuel—(besides wood) 3 tons coal	20.00
Sundry expenses for repairs, etc.	25.00
Charge to cover deterioration in plant	50.00
Total	<u>\$1,157.80</u>
Number of trees sprayed, about	11,000
Average cost per tree, about	10 cents

These figures include the spraying of many large bearing apple trees which were growing in the peach orchard.

TABLE I.—YALESVILLE EXPERIMENTS. DORMANT TREES SPRAYED MARCH 10-12, 1903.

Experiment Number.	Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.	Effect of treatment on trees.
					Winter-killed.	Killed by treatment.	Alive after treatment.		
1	Peach.		Moderately infested.	Lime, Sulphur, Salt. Formula No. 1.	23.2	67.8	9.	88	No injury.
2	"		"	20 lbs. lime.	18.8	77.9	3.5	96	"
3	"		"	14 lbs. sulphur.	19.7	73.3	7.	92	"
4	"		"	10 lbs. salt.	22.8	64.2	13.	83	"
5	"		"	40 galls. water.	18.5	77.5	4.	95	"
6	"		"	"	23.	---	---	---	---
7	"		"	"	21.3	---	---	---	---
14	"		"	"	19.	74.	7.	91	"
15	"		"	"	23.6	---	---	---	---
Average					21.1	72.4	6.9	91	
8	Peach.		Moderately infested.	Formula No. 2.	12.4	83.1	4.7	94	"
9	"		"	20 lbs. lime.	25.	---	---	---	---
10	"		"	20 lbs. sulphur.	20.6	---	---	---	---
11	"		"	10 lbs. salt.	13.5	83.5	3.	96	"
12	"		"	40 galls. water.	25.7	64.3	10.	86	"
13	"	11,000	"	"	20.	---	---	---	---
Average					19.5	76.9	5.9	92	

TABLE II.—YALESVILLE EXPERIMENTS. DORMANT TREES SPRAYED MARCH 20,* 1903.

Experiment Number.	Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.	Effect of treatment on trees.
					Winter-killed.	Killed by treatment.	Alive after treatment.		
16	Peach.		Moderately infested.	Lime and Sulphur.	25.9	74.1	0	100	No injury.
17	"		"	20 lbs. lime.	21.9	73.1	5	93	"
18	"		"	14 lbs. sulphur.	18.4	81.6	0	100	"
19	"		"	40 galls. water.	15.6	83.4	1	98	"
20	"		"	"	29.4	70.6	0	100	"
21	"		"	"	22.9	77.1	0	100	"
22	"		"	"	20.7	76.3	3	96	"
23	"		"	"	15.5	83.9	0.6	99	"
24	"		"	"	22.3	77.7	0	100	"
25	"		"	"	17.9	82.1	0	100	"
26	"	25	"	"	17.	83.	0	100	"
27	"		"	"	18.6	81.4	0	100	"
Average					20.5	78.6	0.8	98	

* These trees were not well coated on March 20th on account of winds, and were again sprayed in April with a mixture containing salt.

The average cost per tree could have been lessened by using two lines of hose on each pump, as one man can easily pump for two lines of hose.

Most of the orchard was sprayed with a mixture containing 20 pounds lime, 14 pounds sulphur, 10 pounds salt and 40 gallons water. The lime was slaked carefully, the sulphur and salt added and the whole boiled slowly for about one and one-half hours.

A portion of the orchard was sprayed with this mixture in November and December, 1902, but as an examination in March showed that there were still many living insects, these trees were again sprayed during the spring.

About thirty days, with the entire force at work, were required to spray the 11,000 trees.

Results at Yalesville.

The buds were well developed and were opening before the spraying could be finished. Some of these were injured. Otherwise there was no injury to the trees.

The percentages of insects living on June 17th, given in Tables I and II, probably do not represent accurately the number that brought forth young this season, for some of these were not healthy when examined and doubtless would not be able to reproduce. An examination of the orchard on September 11th, nearly three months after the breeding season began, showed that the results had been generally satisfactory, as it was extremely difficult to find living scales on the sprayed trees. None were found on the trees which were sprayed twice (December and April).

Very little difference could be seen in the effects of mixtures containing different quantities of sulphur.

A portion of the orchard was sprayed very late just before the leaves appeared, and some trees were in blossom. The open buds were destroyed, but the mixture remained for a longer time on these trees, doubtless on account of being protected by the foliage. Six months after spraying, the trunks and larger branches were still white.

One small orchard owned by Barnes Brothers was not sprayed at all, and Mr. Barnes states that this orchard produced peaches

that were badly infested with the "scab" fungus. Fruit of the same variety from a near-by sprayed orchard was almost entirely free from "scab," indicating strongly that the lime, sulphur and salt mixture, as had been supposed, is of considerable value as a fungicide.

Westville Experiments.

The trees that were here treated were all pear, and set in nearly a square block having fifteen rows with ten to eleven trees in each row. Nearly all of the trees were badly infested and some had been killed by the scale and were removed, so that only 144 trees were actually sprayed in this experiment. The scales had completely encrusted many trees and greatly impaired their vitality: otherwise the conditions were favorable for experimental spraying work.

The spraying was done on April 1st, a bright sunny day, with a breeze from the northwest. The orchard was divided into sections for treatment with the different insecticides. Beginning on the west side, the first row of nine trees was sprayed with Derrick crude oil and water (25 per cent. oil) applied with a "Success" kerosene bucket sprayer. The second, third, fourth and fifth rows were sprayed with whitewash, using 20 pounds of lime to 40 gallons of water. The sixth row was sprayed with sulphide of potash and lime in water (5 pounds sulphide of potash, 5 pounds of lime, 10 gallons of water). The seventh and eighth rows were sprayed with strong Bordeaux mixture composed of 5 pounds of copper sulphate, 5 pounds of lime and 20 gallons of water.

The ninth, tenth, eleventh and twelfth rows were sprayed with the lime and sulphur mixture (no salt), containing 20 pounds of lime, 14 pounds of sulphur and 40 gallons of water, the lime and sulphur being boiled together in a concentrated solution for one hour.

The thirteenth, fourteenth and fifteenth rows were sprayed with the regular lime, sulphur and salt mixture, made by boiling together for one hour 20 pounds of lime, 14 pounds of sulphur, 10 pounds of salt and enough water added to make 40 gallons.

The lime, sulphur and salt, and the lime and sulphur mixtures were boiled for about one hour in a large iron kettle devised for cooking stock feed.

TABLE III.—WESTVILLE EXPERIMENTS. DORMANT TREES SPRAYED APRIL 1, 1903.

Experiment Number.	Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.	Effect of treatment on trees.
					Winter-killed.	Killed by treatment.	Alive after treatment.		
82	Pear.		Badly infested.	20 p. c. Crude Oil in water.	24.	76.	0	100	No apparent injury.
83	"		"	"	24.6	75.4	0	100	"
84	"		"	"	21.8	78.2	0	100	"
85	"		"	"	17.	83.	0	100	"
86	"		"	"	38.	62.	0	100	"
87	"		"	"	36.5	63.5	0	100	"
88	"	9	"	"	37.	63.	0	100	"
Average					28.4	71.6	0	100	
103	Pear.		Badly infested.	Lime and Sulphide of Potash	23.	69.	8.	89	"
106	"		"	10 lbs. sulphide of potash,	43.6	54.9	1.5	97	"
107	"	11	"	10 lbs. lime, 20 galls. water.	17.	72.	11.	86	"
Average					27.5	65.3	6.8	91	
104	Pear.		Badly infested.	Strong Bordeaux Mixture.	25.9	62.1	12.	83	"
105	"		"	5 lbs. copper sulphate.	24.7	66.4	8.9	88	"
108	"		"	5 lbs. lime.	24.	56.	20.	74	"
109	"		"	20 galls. water.	30.9	65.1	4.	93	"
110	"		"	"	27.	62.	11.	85	"
111	"	20	"	"	12.3	77.7	10.	88	"
Average					24.1	64.9	10.9	85	

TABLE IV.—WESTVILLE EXPERIMENTS. DORMANT TREES SPRAYED APRIL 1, 1903.

Experiment Number.	Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.	Effect of treatment on trees.
					Winter-killed.	Killed by treatment.	Alive after treatment.		
89	Pear.		Badly infested.	Whitewash.	36.8	39.2	24.	62	No apparent injury.
90	"		"	20 lbs. lime.	35.5	50.5	14.	78	
91	"		"	40 galls. water.	26.4	60.6	13.	82	
92	"		"	"	24.	51.	25.	67	
93	"		"	"	19.4	66.6	14.	82	
94	"		"	"	28.	52.	20.	72	
95	"		"	"	32.	54.	14.	80	
96	"		"	"	34.8	36.2	29.	55	
97	"		"	"	18.9	65.1	16.	80	
98	"		"	"	24.	68.	8.	90	
99	"		"	"	29.	25.	46.	35	
100	"		"	"	24.	54.	22.	71	
101	"	37	"	"	32.8.	57.2	10.	85	
Average					28.1	52.2	19.	72	

TABLE V.—WESTVILLE EXPERIMENTS. DORMANT TREES SPRAYED APRIL 1, 1903.

Experiment Number.	Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.	Effect of treatment on trees.
					Winter-killed.	Killed by treatment.	Alive after treatment.		
112	Pear.		Badly infested.	Lime and Sulphur.	25.	64.	11.	85	No apparent injury.
113	"		"	20 lbs. lime.	22.	66.	12.	84	"
114	"		"	14 lbs. sulphur.	37.	58.	5.	92	"
115	"		"	40 galls. water.	25.6	64.4	10.	86	"
116	"		"	"	26.5	60.5	13.	82	"
117	"		"	"	22.	75.	3.	96	"
118	"		"	"	32.5	45.5	22.	67	"
119	"		"	"	33.	63.	4.	94	"
120	"		"	"	24.	70.	6.	90	"
121	"		"	"	20.5	72.5	7.	91	"
122	"		"	"	25.	67.7	7.3	90	"
123	"	39	"	"	30.	68.1	1.9	97	"
Average					26.7	64.5	8.5	88	No apparent injury.
124	Pear.		Badly infested.	Lime, Sulphur, Salt.	26.9	70.1	3.	95	"
125	"		"	20 lbs. lime.	23.9	72.1	4.	94	"
126	"		"	14 lbs. sulphur.	25.	67.4	7.6	89	"
127	"		"	10 lbs. salt.	33.	65.	2.	97	"
128	"		"	40 galls. water.	30.9	65.1	4.	94	"
129	"		"	"	14.	83.2	2.8	96	"
130	"		"	"	31.	58.	11.	84	"
131	"	28	"	"	21.5	76.5	2.5	97	"
Average					25.7	69.8	4.8	93	

With the exception of the oil, all the spraying was done with an "Eclipse" barrel pump mounted on a two-wheeled cart and fitted with two lines of hose, bamboo extensions and double Vermorel nozzles.

Results at Westville.

The first row of trees sprayed with 25 per cent. crude oil mixed with water apparently suffered no injury from the treatment and no living insects could be found on the twigs examined. In former experiments, however, trees have been injured by oils, and in other states, notably Ohio, orchards have been seriously damaged by their use. The pumps for mixing oil and water are not reliable, and for these reasons the oils must be used cautiously in Connecticut.

The whitewash alone was not a success, because it washed off quickly and did not kill the scales. If it could be made to remain upon the trees as a coating until after the breeding season begins, it might be of considerable value as a mechanical barrier to the emergence of the young insects. A considerable number (ranging from 8 to 46, with an average of 19, per cent.) of the female scales were not killed by the whitewash.

Similar, though somewhat more satisfactory results, were obtained from the use of the strong Bordeaux mixture. This remained on the trees for a much longer time than the whitewash. But the cost of this mixture together with the results obtained do not warrant its use as a spray to kill the San José scale-insect.

The lime, sulphur and salt mixture made by boiling gave fairly satisfactory results, though more living insects were found than where the oil was applied. The trees remained white for quite a long time, and some of the mixture could still be seen on the under sides of the branches when the trees were examined on September 14th.

What has been said of the results attending the application of the lime, sulphur and salt mixture is also true of the sulphide of potash and lime, prepared without boiling. This was effective in killing the scales and did not wash off badly. It is too expensive for common orchard spraying, but is a convenience when only small quantities of the mixture are required.

The lime and sulphur (no salt) remained on the trees better than any other preparation except the strong Bordeaux mixture, but a larger percentage of insects survived than was the case where salt was used.

The results of the Westville experiments cannot be called satisfactory. Owing to the badly infested condition of the trees, more scales survived the treatment than in the other experiments. It is evident that the lime, sulphur and salt mixture, which forms a hard coating over the branches, does not have the penetrating power of the oils, and therefore is less effective where the trees are covered with several layers of scale-insects.

In such cases it would seem best to give two treatments with the lime, sulphur and salt where feasible—one in the fall soon after the leaves drop and another in spring just before the leaves appear.

Spraying at Southington.

Most of the trees sprayed were in a small peach orchard containing 200 trees. Fifty good-sized apple trees near-by were also treated. The peach trees were all infested by the scale-insect, though most of them had not been greatly injured. It was possible to find scales on nearly every tree. The orchard was on level ground and the trees were not large, making it an ideal place to conduct spraying experiments.

A man and pair of horses were hired for carting the water and the spraying mixture, and a Kinney "Safe" steam engine was hired from the town to boil the lime, sulphur and salt mixture. By attaching two lines of hose to the boiler, the mixture was boiled in two barrels at once, each barrel containing enough materials to make two barrels of mixture when diluted ready for application. The capacity of the boiler was sufficient to do twice the amount of work, as the steam had to be nearly shut off in order to prevent a too violent agitation of the liquid. The engine with boiler is shown mounted on a wagon on Plate II, a.

The spraying pump and barrel were mounted upon a wagon and two lines of hose used at the same time, as is shown on Plate III, a. The mixtures used were: Whitewash—20 pounds lime, 40 gallons water; lime, sulphur and salt—20 pounds lime, 14 pounds sulphur, 10 pounds salt, 40 gallons water; lime and sulphur—20 pounds lime, 14 pounds sulphur, 40 gallons water;

TABLE VI.—EXPERIMENTS AT SOUTHINGTON. DORMANT TREES SPRAYED MARCH 26-28, 1903.

Experiment Number.	Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of two Scales on Twigs—			Percentage efficiency of treatment.	Effect of treatment on trees.
					Winter-killed.	Killed by treatment.	Alive after treatment.		
28	Peach.		Thoroughly infested but not seriously injured.	White wash.	12.	69.	19.	78	No injury.
29	"		"	20 lbs. lime.	15.5	59.5	25.	70	"
33	"		"	40 galls. water.	18.	60.	22.	73	"
34	"		"	"	12.	63.	25.	71	"
35	"		"	"	16.	64.	20.	76	"
38	"		"	"	24.4	56.6	19.	74	"
39	"		"	"	27.	25.	48.	34	"
40	"		"	"	23.3	66.7	10.	86	"
44	"		"	"	17.7	61.3	21.	74	"
45	"		"	"	18.	62.	19.	75	"
46	"		"	"	28.7	46.3	25.	65	"
48	"		"	"	25.4	53.6	21.	71	"
50	"		"	"	25.	59.	16.	78	"
51	"		"	"	24.7	34.3	41.	45	"
58	"		"	"	20.5	44.5	25.	56	"
59	"		"	"	39.	46.	15.	75	"
60	"		"	"	17.	67.	16.	80	"
61	"		"	"	22.	58.	20.	74	"
62	"	100	"	"	26.6	60.4	13.	82	"
Average					21.7	55.5	22.	70	

TABLE VII.—EXPERIMENTS AT SOUTHTON. DORMANT TREES SPRAYED MARCH 26-28, 1903.

Experiment Number.	Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.	Effect of treatment on trees.
					Winter-killed.	Killed by treatment.	Alive after treatment.		
30	Peach.		Thoroughly infested, but not greatly injured.	Lime and Sulphide of Potash.	13.7	81.3	5.	94	No injury.
31	"		"	10 lbs. sul. potash.	18.	81.1	0.9	99	"
64	"		"	10 lbs. lime.	25.	71.6	3.4	95	"
65	"		"	20 galls. water.	27.	72.	1.	98	"
66	"	12	"		19.8	80.2	0	100	"
Average					20.7	77.2	2.	97	
32	Peach.		Thoroughly infested, but not greatly injured.	Lime and Sulphur.	25.	72.	3.	96	"
37	"		"	20 lbs. lime.	23.	73.4	3.6	95	"
41	"		"	14 lbs. sulphur.	24.	72.	4.	94	"
42	"		"	40 galls. water.	20.	79.4	0.6	99	"
43	"		"	"	25.	73.	2.	97	"
67	"		"	"	25.8	70.4	3.8	94	"
68	"	61	"	"	18.	80.	2.	97	"
Average					22.9	74.3	2.7	96	

TABLE VIII.—EXPERIMENTS AT SOUTHINGTON. DORMANT TREES SPRAYED MARCH 26-28, 1903.

Experiment Number.	Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.	Effect of treatment on trees.
					Winter-killed.	Killed by treatment.	Alive after treatment.		
54	Peach.		Thoroughly infested, but not greatly injured.	Lime, Sulphur, Salt.	27.	71.	2.	97	No injury.
55	"		"	"	21.	77.	2.	97	"
57	"		"	20 lbs. lime.	31.	67.	2.	97	"
68	"		"	14 lbs. sulphur.	25.9	72.7	1.4	98	"
69	"		"	10 lbs. salt.	20.7	76.8	2.5	96	"
70	"		"	40 galls. water.	29.7	69.7	0.6	99	"
71	"		"	"	29.6	70.4	0	100	"
73	Apple.	27	"	"	40.9	57.1	2.	96	"
74	"		"	"	66.6	30.6	2.8	91	"
75	"		"	"	65.	31.	4.	88	"
76	"		"	"	50.	*	---	---	"
77	"		"	"	42.6	55.4	2.	96	"
78	"		"	"	20.	75.2	4.8	94	"
79	"		"	"	57.6	39.7	2.7	93	"
80	"	50	"	"	66.	30.7	3.7	90	"
Average					39.5	58.8	2.3	95	

* Tree dead. Killed by scale-insect.

and lime and potassium sulphide—20 pounds lime, 20 pounds potassium sulphide, 40 gallons water. It was planned to use 25 per cent. of crude oil on a few trees, but the pump was not working properly on the days the spraying was done, and this had to be abandoned.

The trees were sprayed on March 26, 27 and 28, during fine weather, though a shower stopped the work before the apple trees were finished late in the afternoon of March 28.

The results are tabulated on pp. 15, 16 and 17.

Results at Southington.

The results obtained from the whitewash are disappointing. It did not remain long upon the trees and was not effective in destroying the scales. The trees were sprayed with kerosene emulsion in August (see page 22).

The lime, sulphur and salt, the lime and sulphur, and the lime and potassium sulphide mixtures were destructive to the scale and remained upon the trees for a long time. In fact, it was quite noticeable on the under sides of the branches when the orchard was visited on September 9th, and living scale-insects were very scarce on the trees in spite of the fact that badly infested trees were not far distant.

New Haven Experiments.

It has been stated on page 3 that the fruit trees on the Station grounds were found to be infested. The discovery was made late in the season, but not too late to spray the trees before the leaves appeared. None of the fruit trees were badly infested though nearly all were infested to a slight degree.

Most of these trees (27) were sprayed with the lime, sulphur and salt mixture, 6 with whitewash and 2 with the Oregon wash (lime, sulphur and copper sulphate mixture). The lime, sulphur and salt mixture was boiled in barrels with steam from the heating system.

The following table gives the chief data:—

TABLE IX.—NEW HAVEN EXPERIMENTS. DORMANT TREES SPRAYED MARCH AND APRIL, 1903.

Experiment Number.	Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.	Effect of treatment on trees.
					Winter-killed.	Killed by treatment.	Alive after treatment.		
132	Apple.	8	Slightly infested.	Lime, Sulphur, Salt.	10.	85.	5.	96	No injury.
				20 lbs. lime.					
				14 lbs. sulphur.					
				10 lbs. salt.					
				40 galls. water.					
133	Pear. Plum. Peach. Cherry. Willow.	11	"	"					"
		2	"	"					"
		4	"	"					"
		2	"	"					"
		1	Badly infested.	Lime, Sulphur and Copper Sulphate.	32.	61.4	6.6	90	"
134	Apple.	1		20 lbs. lime. 14 lbs. sulphur. 10 lbs. cop. sul. 40 galls. water.	25.	50.	25.	50	"
			Slightly infested.						
Average	Pear.	6	Slightly infested.	Whitewash. 20 lbs. lime. 40 galls. water.	28.5	55.7	15.8	70	"
		35			----	----	----	----	"

Results at New Haven.

Trees sprayed with the whitewash were so slightly infested that it was difficult to find specimens upon the twigs. They appeared very white when first sprayed, but the coating soon washed off and disappeared long before the lime, sulphur and salt.

The mixture containing copper sulphate in place of salt (Oregon wash), was dark-green or nearly black in color and could scarcely be seen on the bark. This also washed off early, though in one case it was fairly effective in destroying the scales.

The lime, sulphur and salt, however, was the most satisfactory of the three mixtures used at the Station.

TABLE X.—PERCENTAGE EFFICIENCY OF INSECTICIDES.

Materials.	Percentage Efficiency of Insecticides at				Average for these localities.
	Yalesville.	Westville.	Southington.	New Haven.	
Lime, Sulphur and Salt, Formula No. 1	91	93	95	96	94.5
“ “ “ “ “ No. 2	92	--	--	--	--
Lime and Sulphur	98	88	96	--	94
Lime, Sulphur and Copper Sulphate ..	--	--	--	70	--
Lime and Sulphide of Potash	--	91	97	--	94
Strong Bordeaux Mixture	--	85	--	--	85
Whitewash	--	72	70	--	71
Twenty-five per cent. Crude Oil in water	--	100	--	--	--

Other Experiences.

Several small trees including peach, cherry, pear, Japan plum, and hawthorn in a New Haven city garden were sprayed with the lime, sulphur and salt mixture on January 19th.

The mixture was boiled in a kettle on the kitchen range and applied thoroughly. Though the mixture seemed to become well dried upon the trees, a heavy rain fell on the 21st and it washed off badly. Two months after applying, no traces of the spray could be seen on the trees, and a very large proportion of the scales were not killed, as the trees were very badly infested during the latter part of the summer.

In another yard six small trees, including quince, pear, apple and peach, were sprayed on March 18th, with the lime, sulphur and salt mixture.

Though some of the trees were quite badly infested, the treatment seems to have been successful, as very few living scales could be found when the trees were examined on September 15th.

Considerable spraying with the lime, sulphur and salt mixture was done in the large orchards of the State. George F. Platt & Son of Milford sprayed 8,000 peach trees last spring just before the buds started, at a cost of two cents per tree. While the results were generally satisfactory, on account of unfavorable weather and high winds at spraying time, many scales survived and multiplied rapidly during the season. The owners intend to spray the orchard again as soon as the leaves fall this autumn.

Mr. J. H. Hale of South Glastonbury sprayed about 11,000 trees with the mixture, with satisfactory results.

N. D. Platt & Son of Milford sprayed about 800 six-years-old peach trees at a cost of about six cents per tree. The results were successful.

Mr. N. H. Sherwood of Southport sprayed his entire orchard of 2,200 peach trees with lime, sulphur and salt with satisfactory results.

One grower of West Hartford sprayed a few trees, using 150 gallons of the mixture. The work was satisfactory, as nearly all of the scales were killed. The treatment will be repeated next season. Another West Hartford peach grower reported that 1,000 of his trees were sprayed with the mixture during early spring with successful results in killing the scale. 1,000 trees were sprayed in Cromwell, and many other growers have each used the mixture on a smaller number of trees.

In the orchard of the Highland Fruit Co. at Wallingford, 1,200 five-year-old peach trees were sprayed with 25 per cent. crude oil in the spring of 1903. The work was done thoroughly, the results were satisfactory, and the cost was three cents per tree on the average.

Mr. Linus H. Hall of Wallingford reports that 1,200 large trees in his orchard have been sprayed for two seasons with 25 per cent. crude oil. The average cost was three and one-half cents per tree for each treatment, and the results were fairly satisfactory.

Mr. Z. P. Beach of Wallingford has done more or less spraying with 25 per cent. crude oil each year for three years in his orchard of 4,500 peach trees, all of the trees being sprayed in 1902. The scale has been held in check and only a few trees injured by the oil.

SUMMER SPRAYING WITH KEROSENE EMULSION.

After it was found that the whitewash applied to the peach trees at Southington had proved unsuccessful in destroying the scale-insects, kerosene emulsion was applied on August 10th, to kill the young and prevent to some extent the very rapid multiplication of the scales for the season.

As the pumps for making a mechanical emulsion were not in working condition, it was necessary to prepare a soap emulsion. Two formulas were employed:

No. 1.	$\frac{1}{2}$ lb. common soap.....	} 6.6 per cent. kerosene.
	2 gallons kerosene.....	
	28 gallons water	
No. 2.	$\frac{3}{4}$ lb. common soap.....	} 15 per cent. kerosene.
	6 gallons kerosene.....	
	34 gallons water	

In each case the soap was dissolved in hot water, the oil added, and the whole churned violently for a short time until a white creamy mass formed, which was then diluted and applied.

Fourteen trees were sprayed with emulsion made from formula No. 1, and eighty-six trees with formula No. 2. No injury was done to the trees except possibly the dropping of a few leaves, but this was scarcely perceptible.

The results of this summer treatment were unsatisfactory. Though a large number of insects were killed, many came through alive and when the trees were examined on September 9th the young were numerous on these trees. Formula No. 1 killed about half the scales and formula No. 2 killed from two-thirds to four-fifths of them. But enough escaped to keep the trees badly infested.

MAKING THE LIME, SULPHUR AND SALT MIXTURE.

The materials needed for making the lime, sulphur and salt mixture are: good fresh stone lime (the best grade finishing lime), sulphur flour, or the sublimed flowers of sulphur, and a

cheap grade of salt. The agricultural or hay salt is commonly used.

While the operation is quite simple, much care should be used in making the mixture. We found that small quantities, sufficient to spray one or two hundred trees, could be boiled nicely over a fire in a set kettle, such as is used to heat water and cook feed for stock on many of the farms.

For making large quantities, however, it is necessary to boil it by steam from a boiler. Where a boiler is handy, it is an easy matter to procure the necessary barrels for holding the mixture and the hose to carry the steam from the boiler to the barrels. Often one can hire a small portable boiler for the occasion. Where spraying is done on an extensive scale, plants have been established for cooking the mixture in large quantities.

In whichever way the mixture is made, the process is similar and the same care should be taken in preparing it.

The formula used chiefly in our experimental work was 20 pounds lime, 14 pounds sulphur and 10 pounds salt to 40 gallons water. This is simply two-thirds the amount of the 30-20-15-60 formula, and is more convenient, as it just fills a barrel.

The lime should be thoroughly slaked. Much of the trouble in straining and also the clogging of the pumps is caused by the improper slaking of the lime.

The sulphur and salt are then added and the whole boiled for an hour or an hour and a half. The mixture should be kept well stirred all the while it is boiling; while the sublimed flowers of sulphur is more soluble than the sulphur flour, it is liable to form in lumps, which must be crushed against the sides of the kettle or barrel, and consequently it will be necessary to boil it as long as it will the sulphur flour.

After boiling, add water to make the right proportion.

The mixture should be strained through a strainer having about twenty meshes to the inch.

If the mixture has been thoroughly prepared, very little sediment will remain, and there will be no trouble from clogging the nozzles.

The pumps should be thoroughly cleaned every night after spraying. It has been recommended to run a little vinegar or some weak acid through the pump to neutralize the effects of the alkaline solution.

All receptacles should be iron or wood, the strainer iron or brass, and under no consideration should copper be used.

On May 12th, a piece of copper wire weighing $4\frac{1}{2}$ grams was boiled for one hour in the lime, sulphur and salt mixture. During this time the weight had been reduced to $3\frac{1}{2}$ grams by the corrosive action of the mixture. In standing three hours after boiling the weight was further decreased two-fifths of a gram.

At the same time brass wire weighing $6\frac{1}{2}$ grams was boiled for one hour in the same kind of mixture with no decrease in weight.

The metals were allowed to stand in the mixture and were examined about September 1st. The brass was slightly corroded, but no trace of the metallic copper could be seen.

Laboratory tests were made with the different grades of sulphur, light sulphur flour, heavy sulphur flour, and flowers of sulphur. The two grades of flour are simply ground brimstone, the "light" being more finely ground than the "heavy." Flowers of sulphur is a sublimated product and the particles are smaller and of different shape than in sulphur flour, and can be readily distinguished under the microscope.

135 grams lime, 90 grams sulphur, and 68 grams salt were the quantities used in the test.

- A contained light sulphur flour.
- B contained heavy sulphur flour.
- C contained flowers of sulphur.

The lime was slaked in each case and one-half pint of hot water added. C was the first to show discoloration due to chemical action. Each boiled at 102° C. After boiling for half an hour a half-pint of hot water was added to each. After boiling one hour, a preliminary test for sulphur was made. A, contained considerable, B, a very small quantity, and C, no undissolved sulphur.

The flowers of sulphur costs a little more than the sulphur flour, but is not so heavy.

Flowers of sulphur weighs	175	pounds	per	barrel.
Sulphur flour (light)	"	225	"	"
" (heavy)	"	275	"	"

The sulphur can be made into a paste before adding, may be slaked with the lime, or may be sifted upon the top of the liquid to avoid lumps.

Finishing lime is preferable as it is nearly pure lime, slakes completely, and contains less dirt than other grades. The lime used in the Southington experiments contained only 54.24 per cent. of lime and 36.04 per cent. of magnesia.

Effect of the Mixture on the Skin.

The lime, sulphur and salt mixture is very irritating to the skin and causes smarting, and finally soreness if the spray is allowed continually to come in contact with the hands and face. Gloves should therefore be worn to protect the hands. For this purpose rubber or oil-skin is preferable. The mixture quickly ruins leather. Cheap masks may be used to protect the face, though this is hardly necessary if the operator keeps on the windward side of the tree when spraying.

Rubbing the face and hands with petrolatum before commencing work is also advisable.

WEATHER NOTES.

One of the greatest drawbacks to using the lime, sulphur and salt mixture in the east is the rainy weather, early in spring common to this section. If the application is followed by a week or more of clear weather, the mixture is doubtless more effective than if rains occur soon after it is applied.

The mixture should at least have time to thoroughly dry upon the trees before it rains.

Notes were kept regarding the weather following our spraying experiments in March and April.

At Southington trees were sprayed on the 27th and 28th of March. About four o'clock on the afternoon of the 28th a brisk shower stopped the work. The 29th was clear. It rained the afternoon of the 30th and hard all night, followed by showers the 31st.

The first of April being a pleasant day, we sprayed at Westville. The 2d was clear and windy. It rained nearly all day the 3d, the 4th rain and snow. The 5th and 6th pleasant weather prevailed. The 7th and 8th were rainy, and in the evening of the 9th there was a heavy shower. From the 10th to the 14th was pleasant. The 15th and 16th were stormy.

From April 17th to the 28th of May no rain fell, excepting May 4th, when we had a light shower that scarcely laid the dust.

For about three weeks following the spraying there was considerable rain, which washed much of the mixture from the trees, and doubtless affected somewhat the results of the experiments.

SUMMARY.

1. During the Spring of 1903, spraying experiments were conducted in Yalesville, Westville, Southington and New Haven, over 11,500 trees being treated. The trees were chiefly peach, pear and apple.

2. The chief mixtures used were: lime, sulphur and salt; lime and sulphur; lime, sulphur and copper sulphate; lime and potassium sulphide; whitewash; strong Bordeaux mixture; twenty-five per cent. crude oil in water, upon dormant trees, and kerosene soap emulsion upon trees in foliage.

3. Most of the trees were sprayed with the lime, sulphur and salt mixture (California wash): this and the lime and sulphur mixture, and the lime and potassium sulphide proved about equally effective in destroying the scales and in sticking to the trees. Whitewash and strong Bordeaux mixture as used in these experiments were unsatisfactory scale-destroyers. The former soon disappeared from the trees while the latter remained about as long as the lime and sulphur mixtures. The Oregon wash (lime, sulphur and copper sulphate) soon disappeared from the trees, though in one case it was quite destructive to the scale-insects. Twenty-five per cent. crude oil in water must be regarded as an excellent scale-destroyer. Though no injury resulted to the trees in these experiments, many trees have been damaged here and in other states, and it is hardly a safe treatment for the average orchardist to use; but the oil mixtures have greater penetrating power than any of the lime and sulphur mixtures, and therefore may be expected to destroy a larger proportion of scale-insects on badly infested trees.

4. Several Connecticut orchardists have sprayed their orchards (containing nearly 40,000 trees) with the lime and sulphur mixtures with generally satisfactory results. Several thousand trees have also been sprayed with oil, with good results, though trees were injured in some cases.

5. The lime and sulphur mixtures remained upon the trees longest when applied just before the leaves appeared, being protected by them. In some cases it washed off and was not effective when applied in the winter.

In orchards where two applications were made (one in late fall and the other in early spring) it was difficult to find any living insects in June.

6. Kerosene emulsion as a summer spray was not particularly successful in our experiments.



a. Trees cut back ready for spraying. Orchard of Barnes Brothers, Yalesville.



b. View of orchard at Southington. Sprayed trees at the right.

ORCHARD TREATMENT AGAINST SAN JOSÉ SCALE-INSECT.





a. Cooking the lime, sulphur and salt mixture at Southington. A Kinney "Safe" engine furnishes steam to boil the mixture in barrels.



b. View in Barnes Brothers' orchards showing elevated storage barrels and spraying barrel and pump mounted on stone drag.

APPARATUS FOR MAKING AND HANDLING THE SPRAYING MIXTURE.



a. Outfit used in Southington Experiments.



b. Outfit employed by Barnes Brothers at Yalesville.

SPRAYING WITH LIME, SULPHUR AND SALT.

